Example of how small RF leakage into BPM signals can affect reported beam position and what happens at transition

Choose bpm signal amplitudes 'bpma' and 'bpmb' and define 'bpmsum'

$bpma := .85 \qquad bpmb := 1 \qquad bpmsum := bpma + bpmb$

Now 'gate' the bpm signals ON between times 1 and 8 and establish RF phase of these signals

$a(t) := bpma \cdot (1 - \Phi(t - 8)) \cdot \Phi(t - 1) \qquad b(t) := bpmb \cdot (1 - \Phi(t - 8)) \cdot \Phi(t - 1)$

$bpmA(t) := a(t) \cdot e^{j \cdot 0} \qquad bpmB(t) := b(t) \cdot e^{j \cdot 0}$

Define RF leakage signal amplitudes in terms of 'bpmsum' (always ON), establish RF phase of the leakage signals, and accomodate transition phase jump

$la := .1 \cdot bpmsum \qquad lb := .05 \cdot bpmsum$

Set initial (pre-transition) phase of leakage 'ptlph' to -45 degrees relative to beam signals, set transition phase jump 'tpj' to -180 degrees, and set transition time to 5

$phis := \frac{3\pi}{8}$

$ptlph := \frac{3 \cdot \pi}{8} \qquad tpj := 2 \cdot \left(\frac{\pi}{2} - phis \right)$

$phla(t) := ptlph + tpj \cdot \Phi(t - 5) \qquad phlb(t) := ptlph + tpj \cdot \Phi(t - 5)$

$leakageA(t) := la \cdot e^{j \cdot phla(t)} \qquad leakageB(t) := la \cdot e^{j \cdot phlb(t)}$

Now total A and B signals are sum of BPM signal and leakage

$A(t) := bpmA(t) + leakageA(t)$

$B(t) := bpmB(t) + leakageB(t)$

Compute measured and actual position as difference-over-sum of A and B signals scaled by 27mm typical for vertical standard MI BPM

$Sum(t) := |A(t)| + |B(t)|$ $\qquad K_0 := 27$

$Diff(t) := |A(t)| - |B(t)|$

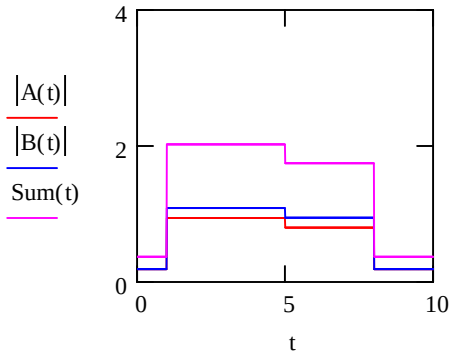
$Measpos(t) := K_0 \cdot \frac{Diff(t)}{Sum(t)}$ $\qquad Actpos(t) := K_0 \cdot \frac{bpmA(t) - bpmB(t)}{bpmA(t) + bpmB(t)}$

$Measpos(4) = -1.975$ $\qquad Actpos(4) = -2.189$

$Measpos(6) = -2.279$ $\qquad Actpos(6) = -2.189$

For these choices of leakage amplitudes and phase find ~0.2 mm position error and 0.3 mm step at transition; different leakage amplitudes and phases will yield different results

Plot of A and B and total Sum Signal Amplitudes, between 0-1 and 8-10 seconds "beam" signal is gated off and only leakage RF appears



Plot of Actual and Measured Beam Position with leakage RF and with phase jump between beam and leakage at transition time